EXAMINATION OF PRECORDIUM & RELEVANT GENERAL PHYSICAL EXAMINATION IN CHILDREN

- Cardiac physical examination is most diagnostic if done correctly.
- Knowledge which determines diagnosis, or help in strong differential diagnosis:
  - Cardiac physiology
  - Auscultation techniques
  - Maneuvers

PHYSICAL EXAMINATION

- Examine whole body for signs of hemodynamic status
- More difficult in infants & children
- Findings are easier to hear in cooperative young children and adolescents than in adults

GENERAL EXAMINATION GUIDELINES

THE STETHOSCOPE

- Should be your own!!!
- Have a separate bell & diaphragm
- Bell allows all frequencies of sounds
- Diaphragm allows middle & high frequency sounds, attenuates low pitched sounds
- Bell to be placed lightly (avoid diaphragm effect)
- Diaphragm should be small enough to fit on the chest of the patient
- Tubing should be short (16-18 inches)
- Earpieces should be comfortable and snug

INSPECTION

- Chest inspection gives clues to cardiopulmonary disease
- Asymmetry can indicate RVE
- Increased A-P chest diameter indicates chronic air trapping /hyperinflation
- Pectus deformities, cardiopulmonary consequences
- Kyphoscoliosis, may be due to cardiopulmonary effect
- Poland’s anomaly (unilateral absence of pectoralis major /minor)
- Harrison’s grooves seen in the lower chest
- Pulsations/rocking seen with large shunts, MR, or AI

APICAL IMPULSE

- NORMAL
  - Visualization to assess ventricular size/thickness
  - Normally distinct & located at 4ICS at MCL
- ABNORMAL
  - Hyper-dynamic impulse in normal location:
    - increased cardiac output or LVH
  - Hyper-dynamic and downward/left ward
  - LVE
  - Indistinct impulse
    - associated with RVH
  - Precordial heave is seen with RV

PALPATION:

- Sometimes overlooked
- Not always helpful
- Use the most sensitive portion of the hand
- Lay the heel of R hand at left sternal border with fingertips pointing to left axilla
RV IMPULSE
- Felt at the LSB, usually slight
- RVH (without RVE), parasternal tap (sharply localized, quickly rising)
- RVE (with or without RVH), parasternal lift (diffuse, gradually rising)

LV/APICAL IMPULSE
- NORMAL
  - Found with fingertips when patient upright
  - Note interspace location, relation to midclavicular/anterior axillary line, amplitude compared to RV impulse
- ABNORMAL
  - Strong impulse is due to ↑ cardiac output or LVH
  - Downward/leftward displacement → LVE (with or without LVH)

THRILLS
- Palpation of a loud murmur
- Found in the precordial, suprasternal, or carotid artery area
- If it is low intensity, probably just a pulsation and NOT a thrill

PERCUSSION
- Usually not performed for cardiac borders, but for lung fields
- Should be done in the upright position (even infants can be held upright...)

AUSCULTATION:
WHERE TO LISTEN?
- Apex/5LICS (mitral area)
- Left lower sternal border/4LICS (tricuspid and secondary aortic area)
- Right middle sternal border/2RICS (aortic area)
- Left middle sternal border/2LICS (pulmonary area)
- Left and right infraclavicular areas
- Left anterior axillary line
- R and L axillae
- R and L interscapular areas of back (for pulmonary/aortic collaterals)

WHERE TO LISTEN (OTHER SITES)
- Lungs
- Cranium (temples/orbits/fontanelle)
- Liver
- Neck (carotid area)
- Abdomen
- Lumbar/abdominal region over renal area
- Mouth/trachea with respiration
- Femoral artery

HOW TO LISTEN
- Have a system, e.g. method of inching
- Listen systematically:
  - S1
  - S2
- Systolic sounds
- Systolic murmurs
- Diastolic sounds,
- Diastolic murmurs

NORMAL HEART SOUNDS
FIRST HEART SOUND (S1)
- Produced by closure of AV valves
- Best heard at the apex and LLSB
- Often sounds single unless slow heart rate
- If split heard better at the apex, may actually be S4 or ejection click
- More low-pitched and long as compared to S2
- Differentiate S1 from S2 by palpating carotid pulse:
  - S1 comes before and S2 comes after carotid upstroke

SECOND HEART SOUND (S2)
- By closure of aortic and pulmonary valves
- Heard as a split which varies with respiration
- Best heard at LMSB/2LICS
- Higher pitched than S1, better heard with bell

S2 SPLITTING (ABNORMAL)
- Persistent expiratory splitting
- ASD
- RBBB
- Mild valvar PS
- Idiopathic dilation of the PA
- WPW
- Widely fixed splitting
- ASD
- RBBB

SINGLE S2
- Occurs with greater impedance to pulmonary flow, P2 closer to A2
- Single and loud (A2):
  - TGA
  - Extreme ToF
  - Truncus arteriosus
- Single and loud (P2):
  - Pulmonary HTN
- Single and soft:
  - Typical ToF
  - Loud (not single) A2:
  - CoA or AI

EXTRA HEART SOUNDS
S3 (gallop):
- Usually physiologic
- Low pitched sound, occurs with rapid filling of ventricles in early diastole
- Due to sudden intrinsic limitation of longitudinal expansion of ventricular wall
- Makes Ken-tuck-y rhythm on auscultation

S3 (cont.):
- Best heard with patient supine or in left lateral decubitus
- Increased by exercise, abdominal pressure, or lifting legs
- LV S3 heard at apex and RV S3 heard at LLSB

S4 (gallop):
- Nearly always pathologic
- Can be normal in elderly or athletes
• Low pitched sound in late diastole
• Due to elevated LVEDP (poor compliance) causing vibrations in stiff ventricular myocardium as it fills
• Makes “Ten-nes-see” rhythm

**S4 (cont.):**
• Better heard at the apex or LLSB in the supine or left lateral decubitus position
• Occurs separate from S3 or as summation gallop (single intense diastolic sound) with S3

**S4 Associations:**
• CHF!!!
• HCM
• severe systemic HTN
• pulmonary HTN
• Ebstein’s anomaly
• Myocarditis

**S4 Associations (cont.):**
• Tricuspid atresia
• CHB
• TAPVR
• CoA
• AS w/ severe LV disease
• Kawasaki’s disease

**CLICK**
• Usually pathologic
• Snappy, high pitched sound usually in early systole
• Due to vibrations in the artery distal to a stenotic valve

**CAN BE ASSOCIATED WITH:**
• Valvar aortic stenosis or pulmonary stenosis
• Truncus arteriosus
• Pulmonary atresia/VSD
• Bicuspid aortic valve
• Mitral valve prolapse (mid-systolic click)
• Ebstein’s anomaly (can have multiple clicks)

**Friction rub:**
• Creaking sound heard with pericardial inflammation
• Classically has 3 components; can have fewer than 3 components
• Changes with position, louder with inspiration

**Murmur:**
• Sounds made by turbulence in the heart or blood stream
• Can be benign (innocent, flow, functional) or pathologic
• Murmurs are the leading cause for referral for further evaluation
• Don’t let murmurs distract you from the rest of the exam!!

**GENERAL DESCRIPTORS (CONT.):**
• Timing within the phase
• Duration within the phase
• Grading 1-6, (faint needs concentration, soft, easily audible, with thrill, harsh with thrill, visible on chest)
• Character/quality
• Location of maximum intensity on the precordium
• Radiation of murmur

MANEUVERS

ROUTINE POSITIONS—
• Supine and standing or sitting examinations should be performed on all patients.

OTHER PHYSICAL MANEUVERS

SQUATTING:
• Increases afterload/systemic vascular resistance, initially increased venous return, increased stroke volume, decreased HR
• Reduces the murmur of AS w/ HCM
• Increases the murmur of MR

SUDDEN STANDING:
• Decreased afterload, decreased venous return and stroke volume, increased heart rate, increased SVR):
• Accentuates the murmur and S4 of subAS, MVP, and HOCM

LEFT LATERAL DECUBITUS POSITIONING OR LEANING FORWARD IN AN UPRIGHT POSITION:
• Apex of the heart falls toward the chest wall
• Brings out mitral valve and aortic valve murmurs

SOME MANEUVERS FOR INNOCENT MURMURS (MORE LATER):
• Jugular vein compression/turning the head can abolish venous hum
• Lying the patient perfectly flat is the most reliable method of quieting the hum.
• Compression of the subclavian artery or shoulder extension can abolish supraclavicular bruit

OTHER MANEUVERS:
• Transient arterial occlusion
• Breath-holding in end-expiration in the upright position or leaning forward
• Deep breath inspiration in upright position
• Lower extremity elevation (passive) while lying down
• Exercise (running in place)
• Isometric handgrips
• Valsalva (straining) maneuver--forced expiration against a closed glottis after full inspiration for at least 10 seconds
• Chemical maneuvers--rarely, if ever, performed today due to better imaging techniques

THE REST OF THE BODY--don't forget it!!

Vital signs:
• Temperature
• Respiratory rate
• Heart rate
• Blood pressure
• Oxygen saturations
• Weight and height
**Lungs:**
- Pulmonary congestion probably nonexistent in infants (more manifest by tachypnea or retractions)
- Cardiac asthma: fine crackles heard in older children associated w/ CHF (coarse crackles indicate a pneumonia)
- Possible signs of increased pulmonary blood flow
- Tachypnea
- Dyspnea
- Retractions
- Flaring
- Grunting
- Panting

**EDEMA:**
- Caused by systemic venous congestion
- Seen more in older children and adults (little evidence of this in infants)
- More often seen in renal- or liver-induced hypoproteinemia (esp. if marked)
- Locations:
  - Periorbital
  - Scrotal
  - Pre-sacral
  - Hand/foot area
- Nonpitting pedal/hand edema or lymphedema in a newborn: think Turner’s or Noonan’s syndrome

**LIVER:**
- Measure at midclavicular line where it crosses the 9th costal cartilage
- Can be right-sided (situs solitus), left-sided (situs inversus), or midline (situs ambiguous--measured subxiphoid)
- Measurements:
  - 2-3 cm below the RCM in the infant
  - 2 cm below the RCM from 1-3 years of age
  - 1 cm below the RCM from 4-5 years of age
- Use warm, gentle hands

**LIVER--ABNORMAL:**
- Hepatomegaly caused by systemic venous congestion
- Right-sided CHF: liver enlarges, becomes firm, loses distinct edge
- Pulsatile liver: tricuspid regurgitation or other cause of elevated R sided pressures
- Hard liver may be more serious than large, soft liver

**SPLEEN:**
- Normally felt in newborns under the LCM
- Significant enlargement can indicate TORCH infection with an associated cardiac lesion
- Isolated splenomegaly is usually not seen w/ CHF

**INFECTIVE ENDOCARDITIS:**
- Splenomegaly
- New/changing murmur
- Fever
• Positive blood cultures
• Neurologic changes
• Peripheral signs of embolic phenomena

**ASCITES:**
• Severe right or right AND left sided CHF--from Fontan anastomosis, dilated cardiomyopathy

**NUTRITION/MUSCLE MASS:**
• Wasting (systemic, bitemporal)--from poor nutrition/high metabolic demand (CHF)

**SKIN:**
• Sweating and pallor (diaphoresis)--associated with increased adrenergic tone

**CYANOSIS OF THE MUCUS MEMBRANES:**
• Central--from > 3g reduced Hb in the arterial blood due to cardiac or pulmonary shunting
• Acrocyanosis--from low cardiac output
• Differential cyanosis

**ARTERIAL PULSES:**
• Assess for rate, rhythm, volume, character
• Evaluate radial, brachial, femoral, pedal (dorsalis pedis or posterior tibialis) pulses
• Also palmar and plantar pulses in newborns
• Congenital absence of dorsalis pedis in 10% of population
• Simultaneous evaluation of both radial pulses and R radial plus a femoral pulse

**RATE:**
• Bradycardic (conditioning, heart block, digoxin toxicity)
• Normal
• Tachycardic (CHF, excitement, fever, anemia, arrhythmia)

**RHYTHM:**
• Regular
• Irregular (can be sinus arrhythmia with respiratory variation or PAC/PVC’s)
• Regularly irregular
• Irregularly irregular (arrhythmia)

**VOLUME:**
• Bounding/water hammer (pulse pressure >30 mmHg in infant, >50 mmHg in child)
• Full
• Normal
• Thready
• low output states: shock, severe CHF, large VSD or PDA
• L sided obstruction: AS, aortic atresia, HLHS
• Absent

**CHARACTER:**
- Normal
- Alternans
- Biferiens
- Paradoxus

**CLUBBING:**
- Thickening of tissues at the base of the nails
- Due to capillary engorgement associated with chronic hypoxemia and polycythemia.
- Seen in cyanotic congenital heart disease and pulmonary disease
- Can reverse after improvement of hypoxemia, can disappear with anemia

**OTHER SYSTEMS**
- Facial features of certain syndromes, chromosomal anomalies, and associations important to recognize:
  - Anomalies of the eyes and lens, nose, ears, mandible/maxilla, tongue, dentition and gingiva, asymmetry of the facial musculature, etc.

**CNS:**
- Developmental delay
- Seizures
- Certain personality traits associated with these findings (usually not in isolation)

**EXTREMITIES:**
- Abnormal palmar creases
- Polydactyly
- Arachnodactyly
- Thumb/radial anomalies
- Phocomelia
- Pseudohypertrophy
- Nail anomalies

**GI TRACT:**
- T-E fistula
- Omphalocele
- Imperforate anus
- Diaphragmatic hernia
- Esophageal or duodenal atresia
- Renal anomalies
- Bladder anomalies
- Gonadal dysgenesis
- External genitalia anomalies
- Nephrocalcinosis

**SKELETON:**
- Scoliosis
- Sternal anomalies
- Tall or short stature
- Hypermobility of the joints
- Fused/hemi/absent/butterfly vertebrae
- Caudal regression

**SKIN:**

- Poor wound healing
- Increased elasticity
- Lentigines/nevi
- Hemangioma
- Petechiae
- Fragility/bruising
- Cafe au lait spots

**ENDOCRINE ANOMALIES:**

- Hypercalcemia
- Hypocalcemia
- Hyper or hypothyroidism
- Hypogonadism
- Renal tubular acidosis

THANKS